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Review article

The Proportion of Lower Limb Running Injuries by Gender, Anatomical Location and Specific Pathology: A Systematic Review

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Abstract
Running is associated with a higher risk of overuse injury than other forms of aerobic exercise such as walking, swimming and cycling. An accurate description of the proportion of running injuries per anatomical location and where possible, per specific pathology, for both genders is required. The aim of this review was to determine the proportion of lower limb running injuries by anatomical location and by specific pathology in male and female runners (≥800m - ≤ marathon). The preferred reporting items for systematic reviews and meta-analyses guidelines were followed for this review. A literature search was performed with no restriction on publication year in Web of Science, Scopus, SportDiscus, PubMed, and CINAHL up to July 2017. Retrospective, cross-sectional, prospective and randomised-controlled studies which surveyed injury data in runners were included. 36 studies were included to report the overall proportion of injury per anatomical location. The overall proportion of injury by specific pathology was reported from 11 studies. The knee (28%), ankle-foot (26%) and shank (16%) accounted for the highest proportion of injury in male and female runners, although the proportion of knee injury was greater in women (40% *vs.* 31%). Relative to women, men had a greater proportion of ankle-foot (26% *vs.* 19%) and shank (21% *vs.* 16%) injuries. Patellofemoral pain syndrome (PFPS; 17%), Achilles tendinopathy (AT; 10%) and medial tibial stress syndrome (MTS; 8%) accounted for the highest proportion of specific pathologies recorded overall. There was insufficient data to sub-divide specific pathology between genders. The predominate injury in female runners is to the knee. Male runners have a more even distribution of injury between the knee, shank and ankle-foot complex. There are several methodological issues, which limit the interpretation of epidemiological data in running injury.

Key words: Running, injury, injury prevention, epidemiology

Introduction

Running is associated with a higher risk of overuse injury (Bertola et al., 2014; Hauret et al., 2015; Salmon et al., 2014) than other forms of aerobic exercise such as walking, swimming and cycling. To unlock the full potential of running as a sport or a vehicle to improve health there is a need to understand the aetiology of injury. In any sport, this process begins by gaining an understanding of the most frequent injuries associated with that sport (Fitzharris et al., 2017).

Preferably, injury epidemiology would be synthesized from high quality studies, using standardised definitions, by way of systematic review and meta-analysis. This poses a challenge to researchers due to the heterogeneity of studies in the literature, which are affected by differences in study populations, designs and injury or exposure definitions. The most recent systematic reviews on running injury (Kluitenberg et al., 2015; Lopes et al., 2012; Nielsen et al., 2012; van der Worp et al., 2015; Videbaek et al., 2015) have highlighted issues such as a lack of standardised injury definitions, the classification of a runner, and the recording of exposure. To minimise the effect of study heterogeneity on the outcome variable of interest, authors of systematic reviews have used strict inclusion-exclusion criteria to answer specific questions about running injury epidemiology or injury epidemiology in specific types of runners. This results in a smaller number of studies being included for review. Reviews that focus on injury incidence require accurate estimates of exposure (van der Worp et al., 2015; Videbaek et al., 2015). Reviews that focus on the prevalence of specific injuries or injuries in a specific population of runners, are limited to those studies including a medical diagnosis or specific type of runner (Kluitenberg et al., 2015; Lopes et al., 2012).

An alternative approach, albeit less sensitive and potentially subject to greater bias, is to use a broad inclusion criteria. This would allow inclusion of a larger population (i.e. recreational, amateur, elite, triathlon, orienteering), and a broader classification of injury (i.e. hip, knee, ankle and foot). Subsequently, sub-group analyses can be performed from studies that clearly describe injury per gender or specific pathology. Gaining a broad understanding of the proportion of running injuries could provide a foundation for the investigation of risk factors associated with running injuries. Furthermore, knowledge of the anatomical locations most commonly affected may assist with the development of standardised study procedures in relation to reporting injury prevalence and incidence. A number of running injury epidemiology studies have recently been published (Altman and Davis, 2016; Hespanhol Junior et al., 2016; Hespanhol Junior et al., 2017b; Kerr et al., 2016; Malisoux et al., 2016b; Smits et al., 2016; van der Worp et al., 2016), therefore the primary aim of this review was to determine the proportion of injuries in male and female runners by anatomical site. A secondary aim was to specify pathologies (self-reported or reported by a health care practitioner), where possible.

Methods

Data sources and search strategy

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This review was prepared and conducted according to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines (Moher et al., 2009). The aim of the search strategy was to find published retrospective, cross-sectional, prospective and randomised-controlled studies that provided survey data. The following electronic databases were searched (from inception) without date restriction to July 2017; and included Web of Science (n = 194), Scopus (n = 215), SportDiscus (n = 72), PubMed (n = 691), SCIELO (n = 5) and CINAHL (n = 57). The last electronic search was conducted on 01/07/2018. Search terms included running* (Boolean Phrase); injury* (Boolean Phrase); prevalence* (Boolean Phrase). In addition, manual searches of the reference lists of four recent running injury systematic reviews (Kluitenberg et al., 2015; Lopes et al., 2012; van der Worp et al., 2015; Videbaek et al., 2015) were undertaken by a single author (PF). All citations were imported to EndNote X7 (Thomson Reuters, USA) and duplicates removed by PF. Articles were screened by title, abstract and finally full text, according to predetermined study criteria (Figure 1). Three authors (PF, CW and KS) independently reviewed all titles and abstracts, and selected those for inclusion. Disagreement was resolved via consensus and a third author (MIJ) was to be consulted if no agreement was reached. Full texts were reviewed by one author (PF) to determine which studies met the inclusion criteria. No hand-search of specific sports medicine journals was performed.

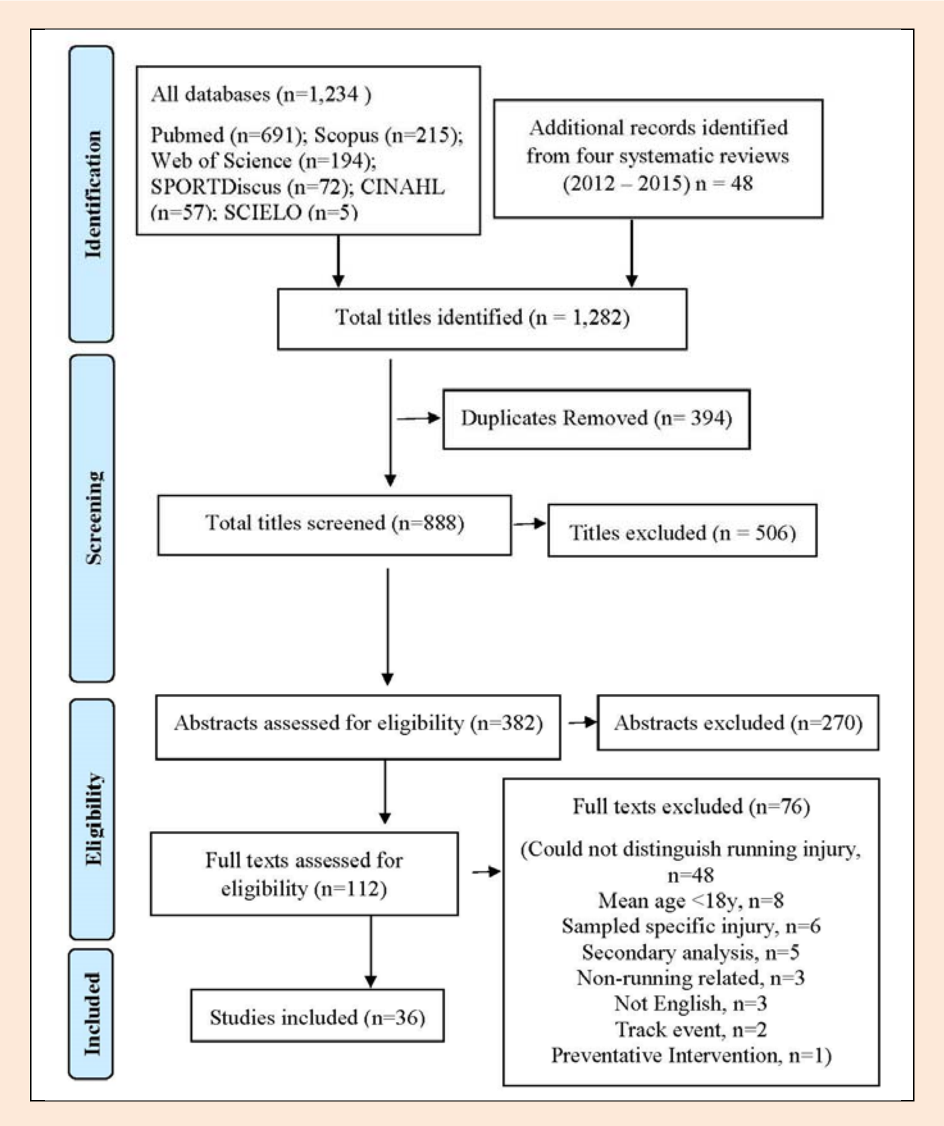

Figure 1. **Flow chart of literature search.**

Inclusion and exclusion criteria

The inclusion criteria were: (1) published peer-reviewed prospective cohort; retrospective cohort; cross-sectional; or randomised controlled studies, (2) reported running injury data in adult (mean age: ≥18 years) runners, (novice, recreational, amateur, elite runners, triathletes and orienteers) competing in distances ≥800m - ≤ marathon), (3) provided the anatomical location of lower limb running injury separate to other injuries/illness (e.g. upper body), (4) written in English, (5) interventions that did not alter the volume of running undertaken, use strategies designed to directly alter pain, and did not report a difference in running related injury (RRI) between intervention and control groups (e.g. the influence of footwear on running injury), (6) included shod injuries separate to barefoot injuries in studies investigating these conditions, (7) not duplicate publications or multiple studies on the same cohort, (8) did not include service personnel (e.g. police, fire service, military) (9) separated lower limb running injuries from other lower limb injuries (e.g. triathlon injuries divided into swim, bike and running), (10) did not recruit participants with a specific type of injury, (11) did not describe track and field competition injuries, (12) presented data as running injury or any lower limb pain regardless of its interference with running.

Data extraction

Data from included studies were extracted by a single author (PF), and checked by MIJ. A standardised data extraction sheet was developed by PF (available on request) where the following data related to study characteristics and injury were extracted: (1) author, year, (2) runner type, (3) gender, age, (4) injury definition, yes/no, (5) study design, (6) time period for retrospective/prospective analysis (7) gender split of injuries, yes/no, (8) sampling method, (9) 6-month or 12-month follow up for prospective or retrospective studies respectively, yes/no, (10) the sample included versus analysed, (11) injury as self-reported, reported by a health professional or diagnosed by a medical doctor (12) injury proportion expressed as a total of all injury, yes/no, (13) consistent mode of data collection, yes/no, (14) all injuries reported, yes/no, (15) running injuries separate, yes/no, (16) anatomical location or specific injury identifiable, yes/no, (17) number of runners, number of injured runners, total injuries, (18) anatomical location of injury, (19) specific type of injury. The primary outcome variable was the proportion of lower limb running injury. Due to the heterogeneity of studies, studies were grouped according to anatomical location, and subsequent subgroup analyses were conducted on data pertaining to specific pathologies. Injuries were categorized by the anatomical regions 'hip' (hip joint/pelvis/groin), 'thigh' (upper leg), 'knee', 'shank' (lower leg), 'ankle-foot' (including toes) and 'other' (not clear diagnosis/location/upper extremity/illness)(Kluitenberg et al., 2015; van Gent et al., 2007). Overall injury prevalence was defined as the number of injured runners divided by the total number of runners in the study. This was calculated from 26-studies where injured runners could be separated from the total number of runners and the total number of running injuries. Descriptive statistics for prevalence were calculated using SPSS. Injury proportions were defined as the total injury number per anatomical region or specific pathology divided by the total number of injuries reported from all sites or pathologies. Specific pathology refers to a pathology with a self-reported or confirmed medical diagnosis.

Quality assessment

Recent systematic reviews on running injury prevalence, incidence and risk factors have used different tools to assess the quality of studies (Lopes et al., 2012; Nielsen et al., 2012; van der Worp et al., 2015; Videbaek et al., 2015). Most tools that have been used can be traced back to epidemiological or occupational studies on general musculoskeletal pain (van der Worp et al., 2015). The tool is often modified to be more 'running' specific and subsequent running reviews often modify it further (Nielsen et al., 2012; Videbaek et al., 2015) or propose their own criteria based on the aims of their review (Lopes et al., 2012). A score out of the total number of criteria or a percentage of positive responses (from yes-no answers) are used to express quality (Kluitenberg et al., 2015; Nielsen et al., 2012; van der Worp et al., 2015).

The main purpose of this study was to determine the proportion of injuries at different anatomical locations in runners and where possible specify the pathology responsible. The level of runner, cause, prevalence or incidence of injury were not of interest thus minimising the importance of methods for randomization for the quality of outcome. Therefore, we used the 10 yes/no criteria proposed by Lopes et al. (2012) as their review was mainly concerned with prevalence and also because the 10 criteria also encapsulated 7 of the 8 criteria recently used by Videbaek et al. (2015) to conduct a similar review. The only difference between our quality assessment and that reported by Lopes et al. (2012) is that where the authors used the words prevalence or incidence, we used the word proportion. Using yes/no criteria a positive score ≥50% is deemed a low risk of bias (Kluitenberg et al., 2015; van der Worp et al., 2015). The detailed criteria can be viewed within the supplementary material from the authors' (Lopes et al. 2012) manuscript but briefly they are as follows: 1) definition of injury reported, yes/no; 2) studies with prospective and cross-sectional designs that present proportion data, yes/no; 3) description of the population or type of runner e.g. 10km, marathon, yes/no; 4) random sampling used (i.e. not a convenience sample), yes/no; 5) data analysis performed on 80% of the participants, yes/no; 6) self-reported injury by the athlete or health care professional, yes/no; 7) consistent mode of data collection, yes/no; 8) diagnosis by a medical doctor, yes/no; 9) a follow-up of 6 months for prospective trials or up to 12-months for retrospective trials, yes/no; 10) injury proportion expressed as a proportion of total injuries, yes/no.

Results

Characteristics of included studies

The literature search yielded 1282 unique citations, of which 112 full texts were obtained and assessed for eligibility. Of the 112 full-text articles, 36 met the eligibility criteria and progressed to data extraction. The reasons for the exclusion of specific studies are displayed in the study flow chart (Figure 1). Of the 36 included studies, 18 were prospective injury audits, 16 were retrospective injury audits, and two were a cross-sectional analyses of current injuries.

Quantitative analysis

Injury proportions by anatomical location were calculated from 10,688 injuries reported from 18,195 runners included in the 36 studies. These proportions were further sub-categorised for females (n = 8 studies, 2,279 injuries) and males (n = 7 studies, 1,875 injuries). Overall injury proportions for specific pathologies were calculated from 3,580 injuries reported by 4,752 runners (n = 11 studies).

There were insufficient data (n = 2 studies) to divide specific pathologies by gender. The overall injury prevalence, calculated from 13,182 runners reporting 5,362 injuries (n = 26 studies), was 42.7% ± 19.8 (range 10 – 92%; 95% confidence interval 34.7% - 50.7%).

Injury proportions by anatomical site

Figure 2 displays the proportion of injuries by anatomical location. The knee (28%) and ankle-foot (26%) regions accounted for over half of all the injuries reported (n = 5,816/10,688). The third highest proportion of injury was at the shank (16%). These data indicate that 70% of all injuries reported were at or below the knee. The hip and thigh regions accounted for 14% of injuries. The remaining injuries (other, 15%) were either of unclear location, from the upper extremity, or illness.

The proportion of injury per anatomical location did not change when analysed by gender. Injuries to the knee and below accounted for the majority of injuries in men (78%) and women (75%). However, the proportions of the three most frequent injuries differ between genders (Figure 3 and 4). Figure 4 illustrates that knee injuries account for 40% of all injuries in women, followed by the ankle-foot (19%) and shank (16%). Injuries are more evenly weighted in men between knee (31%), ankle-foot (26%) and shank (21%) (Figure 3).

The hip and thigh regions accounted for 15% and 18% of all injuries in men and women respectively. Injuries classified as 'other' accounted for 6% and 7% of all injuries in men and women respectively.

Injury proportions by specific pathology

From the 3,580 recorded injuries, 770 were classified as 'other'. The top 10 running injuries recorded from the remaining 2,810 injuries are displayed in Figure 5 and expressed as a percentage of all injuries (n = 3,580).

Discussion

The purpose of this review, was to describe the proportion of running injuries by anatomical location and where possible, specific pathology in men and women. There was sufficient literature to satisfy this aim in relation to anatomical location and specific pathology for both genders combined but only the anatomical location of injury could be divided by gender.

The proportion of running injuries by anatomical site and specific pathology

Unsurprisingly, and in agreement with previous reviews on the topic, the majority (~70%) of running injuries occur at or below the knee (Kluitenberg et al., 2015; Lopes et al., 2012). This finding is true for both men and women.

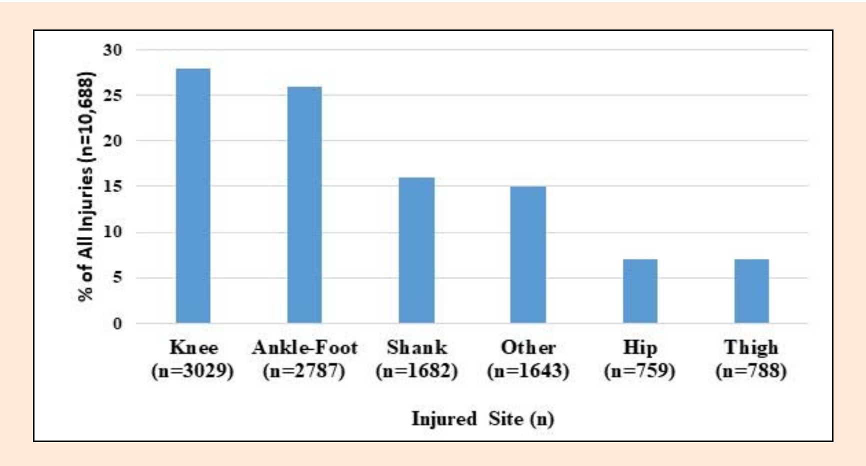

Figure 2. Injury proportions by anatomical site (%).

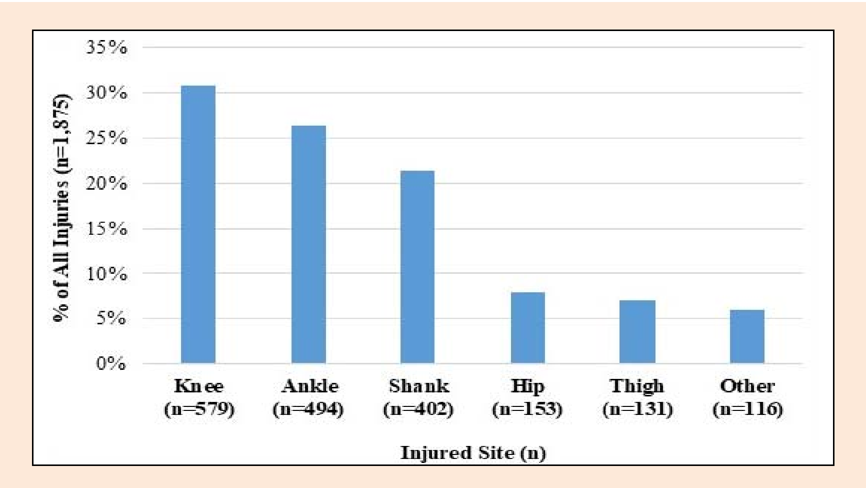

Figure 3. Male injury proportions by anatomical site (%).

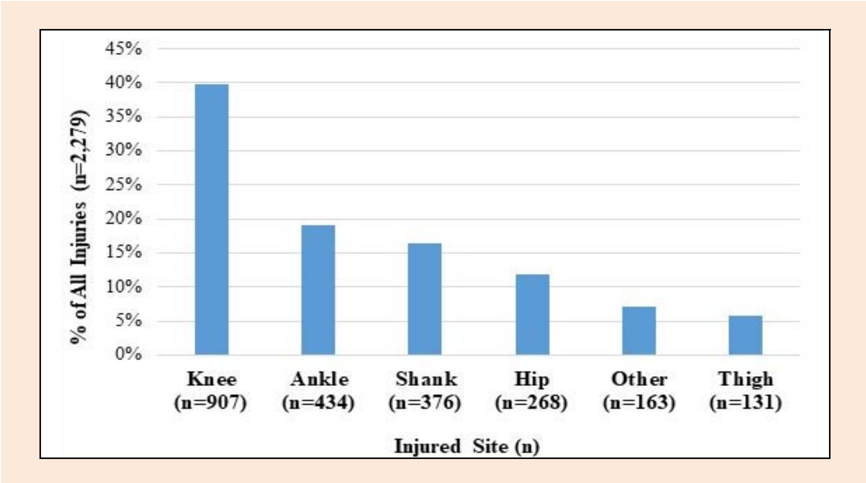

Figure 4. **Female injury proportions by anatomical site (%).**

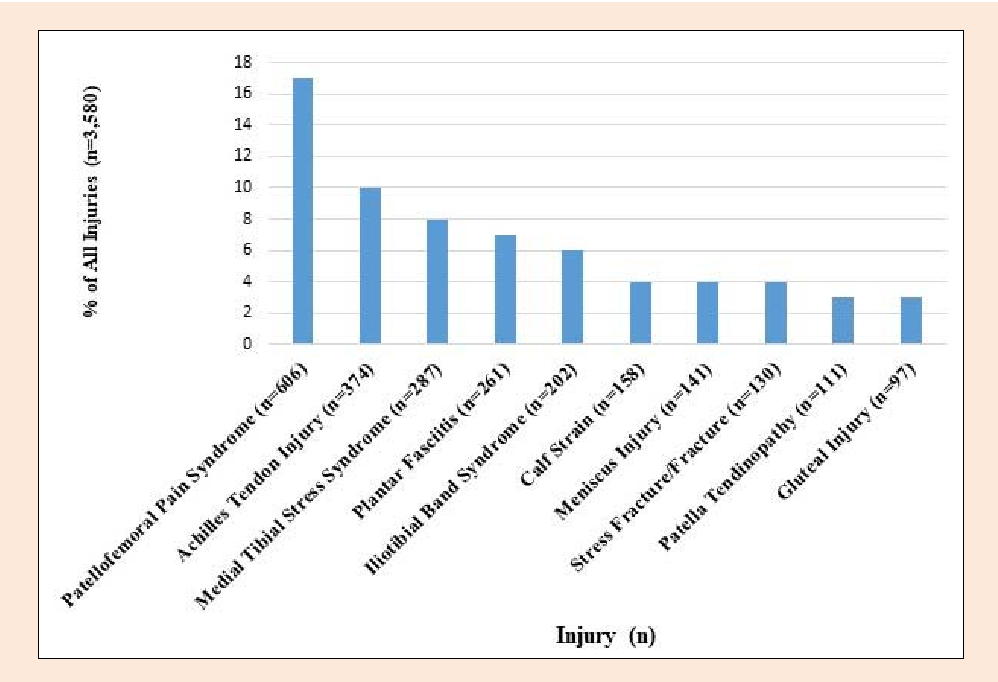

Figure 5. **Top 10 injury proportions by specific pathology (%).**

The top 10 running injuries, identifiable by specific pathology, support this finding. However, although the most commonly injured sites in men and women are the same, the proportions for each site differ. The main difference is that women have a larger proportion of knee injuries (40% of all injuries), relative to men, who experience a similar proportion of knee (31%) and ankle-foot (26%) injuries. This difference may be due to structural differences between males and females, or functional differences in running biomechanics. For example, it is well established that females have a higher incidence of traumatic knee injury in football and basketball relative to their male counterparts (Arendt and Dick, 1995). This has been suggested to be due to altered neuromuscular control in females arising from a greater Q-angle and a greater reliance on quadriceps muscle activity to control landing using more upright postures (Sigward and Powers, 2006). These gender differences will have had an impact on the data we report for specific pathologies. The two most common running injuries were patellofemoral pain syndrome (PFPS) and Achilles tendinopathy (AT), which is in agreement with previous reports on the prevalence of musculoskeletal injury in runners (Junior et al., 2011; Lopes et al., 2012). The proportion of PFPS is far in excess of AT (17% (n = 606) *vs.* 10% (n = 374)) and may reflect a gender bias due to women having more knee injuries. Equally, men have a greater proportion of ankle-foot injuries relative to women (26% (n = 494) *vs.* 19% (n = 434)) which may indicate that the proportion of AT injuries is male biased. This suggestion is supported somewhat by the only two studies included which differentiated gender when reporting specific pathologies (Nielsen et al., 2014; Taunton et al., 2002). Taunton et al. (2002) report gender differences in the proportion of PFPS, AT and plantar fasciitis (PF) reported from an analysis of injuries (n = 2002) obtained from patient records at a sports medicine centre. Women had more

PFPS than men and less AT and PF. In a smaller sample of injuries (n = 254) obtained prospectively, the proportion of PFPS appears to be greater in women and the proportion of AT and PF divided equally between genders. The proportion of specific pathologies will also be influenced by the variability in time to recover from different running injuries and the likelihood of reoccurrence (Nielsen et al., 2014).

Methodological issues with the collation and reporting of running injury data

Although not an aim of the present review, we were able to report the overall prevalence of injury in runners from 26-studies. The overall prevalence of injury (42.7%) varied greatly (10 – 92%) and is in agreement with estimates previously reported (van der Worp et al., 2015; van Gent et al., 2007). The extraction of data highlighted the difficulty in reporting accurate estimates of the proportion, prevalence and incidence of running injury from existing literature. We came across many of the issues reported by previous systematic reviews, such as a lack of consistency in defining a runner, an injury, and exposure. Additionally and most notably, we observed a lack of clarity and consistency amongst studies reporting a) the total number of runners, b) the total number of injured runners c) the total number of injuries, and d) the number of new injuries versus recurrent injuries.

Although many of the studies included in our review scored well in terms of quality assessment (Table 2), it is perhaps more informative to have a qualitative discussion of the issues highlighted by Table 1 and 2. This review raises some important considerations for the design and implementation of future retrospective, cross-sectional or prospective injury studies. The first consideration is in relation to the definition of a runner. Systematic reviews have reported differences in running injuries between various levels (novice, recreational, amateur, competitive, elite) of runners but perhaps with the exception of elite (professional) and beginner (e.g. Netherlands Start to Run Programme) these definitions lack objective data to support their validity. An estimate of the volume (minutes or distance) and intensity (rate of perceived exertion) of running would allow for an accurate description of runner 'level' in studies. The definition of injury poses a challenge toward comparing research findings not just due to the heterogeneity of definitions used, but because the link between pain and injury is not as clear in sports where chronic injury predominates. If a study uses a time loss definition of injury, such as that used in football (Jones et al., 2018), it does not capture sub-clinical pathology which interferes with but does not prevent running. Recently data has been published demonstrating insidious pathology, which rugby players perceive to interfere with performance even though they are classified as uninjured (Partner and Francis, 2018). If a study used a definition of symptoms regardless of its interference with running, it may capture data from high functioning runners who would not be considered injured in the traditional sense. Whether these symptoms are predictive of future risk of injury is unknown. It would seem pertinent for running injury audits to begin to collect data in relation to pain and time-loss injuries in runners. This would begin to shed light on the burden of pain and injury in running.

The anatomical location of injury could be obtained from all studies included in this review but specific pathology could only be identified from 11 studies. This might be expected given the challenges in obtaining an accurate diagnosis. However, the symptoms and location of many running injuries are quite specific, in particular for medial tibial stress syndrome (MTS), PF and AT. Researchers should perhaps consider providing a symptomatic description to runners in relation to the most common running injuries to allow self-report of specific pathology. An alternate approach that would also provide a crude estimate of specific pathology would be to allow self-report of a diagnosis and provide an indication of the source of diagnosis (e.g. physical therapist, medic, friend). Linked to this challenge, is the challenge of providing an accurate estimate of injury between genders. Only 15 studies could be used to report gender differences in injuries by anatomical location and only two reported gender differences for specific pathology. Given the differences in injury proportions between men and women, an important and straightforward way of improving the reporting of data obtained from injury audits is to include gender data.

Assuming the definition of a runner and an injury is appropriate, data is collected by anatomical location and specific pathology, for men and women; the major requirement for obtaining accurate estimates of injury prevalence is to report the total number of runners; the total number of injured runners and the total number of injuries. The majority of studies (19/36 studies) included in this review did not report this clearly. Furthermore, first time injuries need to be separated from recurrent injuries in order to provide an accurate estimate of prevalence. Toward the aim of improving incidence data, quantifying exposure in terms of volume and intensity is important and as mentioned earlier, it would also help to provide a more accurate description of the runner.

Conclusion

In summary, we used broad search criteria to estimate the proportion of running injuries by anatomical location and specific pathologies. For anatomical location these proportions could be further divided by gender. To the best of our knowledge, this is the first review to take this approach. Our findings are in-line with previous research and systematic reviews on the topic. The majority of injuries occur at the knee and below in both genders and this appears to be supported by the proportion of injuries reported by specific pathology. The knee seems to be predominately affected in women. This is also true for males but there appears to be a more even distribution between knee, shank and foot-ankle complexes. Although not the original aim of this review, a major outcome from this review is to highlight the shortcomings in existing methodology and reporting of data which reduces confidence in the data reported by our review and in the reviews of others. Future research employing injury audits should seek to address the issues we have raised above.

Table 1. **Characteristics of included studies.**

Study, year	Study design	Population	Time Period	Anatomical Injury Location	Identifiable Pathologies	Gender Split	Total Runners	Total Injured Runners	Total Injuries
Maughan and Miller (1983)[c,d]	Retrospective Injury Questionnaire	Marathon M & F (32 ± 8 y)	6 months	Y	N	N	497	287	358
Linde (1986)[c]	Prospective Injury Questionnaire	Orienteers M & F (19 – 34 y)	1 year	Y	N	N	42	_*	73
Collins et al. (1989)[c]	Retrospective Injury Questionnaire	Triathlon M & F (mean age: 32 y)	1 year	Y	S	N	257	_*	105
van Mechelen et al. (1993)[b]	RCT (Prospective Questionnaire)	Recreational M (adults)	16 weeks	Y	N	MO	327	_*	49
Jakobsen et al. (1994)[c,d]	Prospective Controlled Trial (Prospective Questionnaire)	Recreational M & F (24 – 56 y)	1 year	Y	S	N	20	13	21
Wen et al. (1998)[d]	Cross-Sectional Associative Study (Retrospective Questionnaire)	Experienced / Marathon Runners M & F (20 – 78 y)	1 year	Y	N	N	304	136	217
Williams et al. (2001)	Cross-Sectional Associative Study (Retrospective Questionnaire)	Amateur M & F (18 – 50 y)	_	Y	N	N	40	_*	134
Chorley et al. (2002)[d]	Retrospective Injury Questionnaire	Novice & Amateur M & F (mean age: 34 y)	3 years	Y	N	N	1548	590	977
Taunton et al. (2003)[a,b]	Prospective Injury Questionnaire	Recreational M & F (<30 - >56y)	13 weeks	Y	N	Y	840	249	_*
Taunton et al. (2002)[a,b,c]	Retrospective Analysis of Medical Records	Amateur M & F (mean age: 34 y)	2 years	Y	Y	Y	2002	2002	2002
Lun et al. (2004)[d]	Cross-Sectional Associative Study (Retrospective Questionnaire)	Recreational M & F (≥18 y)	_	Y	N	N	87	80	170
McKean et al. (2006)[d]	Retrospective Injury Questionnaire	Amateur Young (_ y) and Masters (>40y) M & F	1 year	S	S	N	2825	1309	2271
Van Middelkoop et al. (2008)[b,d]	Retrospective Injury Questionnaire	Marathon Participants M	1 year	Y	N	MO	694	397	550
Knobloch et al. (2008)[c]	Cross-Sectional / Retrospective Exposure and Injury Questionnaire	Master Athletes M & F (42 ± 9 y)	Last season	Y	Y	N	291	_*	677
Van Ginckel et al. (2009)	Prospective associative study	Novice M & F (39 ± 10 y)	10 weeks	Y	S	N	129	_*	69
Ryan et al. (2011)[a,d]	RCT (Prospective Questionnaire)	Recreational F (18 – 50y)	13 weeks	Y	N	FO	81	26	194

[a]= used to report anatomical location of injury in females; [b]=used to report anatomical location of injury in males; [c]=used to report overall proportions of specific injury pathology; [d]= used to report the overall prevalence of injury, *=uncertainty about one of the following: the number of runners, the number of injured runners or the total number of injuries. M= male, F = female. MO=male only, FO=female only.

Table 1. Continued..

Study, year	Study design	Population	Time Period	Anatomical Injury Location	Identifiable Pathologies	Gender Split	Total Runners	Total Injured Runners	Total Injuries
Lopes et al. (2011)[a,b,d]	Cross Sectional Survey	Recreational 5-10km M & F (≥ 18 y)	Current	Y	N	Y	1049	227	_*
Bredeweg et al. (2012)	RCT (Prospective Questionnaire)	Novice M & F (18-65y)	13 weeks	Y	N	N	362	_*	58
Chang et al. (2012)[d]	Retrospective Injury Questionnaire	Recreational 10km – Mara-thon M & F (20 – 50y)	_	Y	N	N	893	396	604
Hespanhol Junior et al. (2012)[c,d]	Retrospective Injury Questionnaire	Recreational M & F (43 ± 10.5 y)	1 year	Y	S	N	200	110	110*
Vadeboncoeur et al. (2012)[a,d]	Cross-Sectional Associative Study (Retrospective Questionnaire)	Recreational Half-M / Marathon M & F (24 – 70y)	30 days	Y	N	Y	194	62	62*
Hendricks and Phillips (2013)[d]	Prospective Injury Questionnaire	Club Level M & F (≥ 19 y)	16 weeks	Y	N	N	50	16	50
Rasmussen et al. (2013)[d]	Retrospective Injury Questionnaire	Recreational Marathon M & F (41 ± 10 y)	12 months	Y	N	N	662	68	_*
Hespanhol Junior et al. (2013)[d]	Prospective Injury Questionnaire	Recreational M & F (43 ± 11 y)	12 weeks	Y	N	N	191	60	84
Ogwumike and Adeniyi (2013)[d]	Cross Sectional Survey	Marathon Participants	_	Y	N	N	920	153	254
Nielsen et al. (2014)[a,b,c,d]	Prospective Cohort Study	Novice M & F (18 – 65 y)	1 year	Y	Y	Y	930	254	_*
Theisen et al. (2014)[d]	RCT (Prospective Questionnaire)	Recreational M & F (42 ± 10 y)	5 months	Y	N	N	247	69	_*
Malisoux et al. (2015)[d]	Prospective Cohort Study	Amateur M & F (>18y)	22 weeks	Y	N	N	264	87	_*
Altman and Davis (2016)[c]	Prospective Cohort Study	Competitive Amateur M & F (18 – 50y)	1 year	Y*	Y	N	201	_*	154
Kerr et al. (2016)[a,b]	Retrospective Analysis of Medical Records	Collegiate M&F	4 years	Y	N	Y	_*	_*	476
Teixeira et al. (2016)[d]	Cross Sectional Interview (Retrospective Pain Recall)	Elite Marathon M & F (30 – 39y)	12 months	Y	N	N	199	149	235
van der Worp et al. (2016)[a,d]	Prospective Cohort Study	Recreational 5 – 10km F (39 ± 12 y)	12 weeks	Y	N	FO	373	93	102
Malisoux et al. (2016a)[d]	RCT	Recreational M & F 18 – 65y	6 months	Y	N	N	553	136	136*
Hespanhol Junior et al. (2016)[c,d]	Prospective Cohort Study (Retrospective & Prospective Questionnaire)	Recreational M & F 44 y ± 11 y	_ 12 weeks	Y	Y	N	89 89	49 24	78 33

[a]= used to report anatomical location of injury in females; [b]=used to report anatomical location of injury in males; [c]=used to report overall proportions of specific injury pathology; [d]= used to report the overall prevalence of injury, *=uncertainty about one of the following: the number of runners, the number of injured runners or the total number of injuries. M= male, F = female. MO=male only, FO=female only.±=standard deviation. _=not reported.

Table 1. Continued..

Study, year	Study design	Population	Time Period	Anatomical Injury Location	Identifiable Pathologies	Gender Split	Total Runners	Total Injured Runners	Total Injuries
Smits et al. (2016)	Prospective Cohort	Novice M & F 18 – 65y	6 weeks	Y	N	N	_*	135	150
Hespanhol Junior et al. (2017a)[c,d]	Prospective Cohort	Trail M&F 43.4 y	14 months	Y	Y	N	223	148	242

[a]= used to report anatomical location of injury in females; [b]=used to report anatomical location of injury in males; [c]=used to report overall proportions of specific injury pathology; [d]= used to report the overall prevalence of injury, *=uncertainty about one of the following: the number of runners, the number of injured runners or the total number of injuries. M= male, F = female. MO=male only, FO=female only.

Table 2. Quality assessment of included studies

Study, year	ID	PDt	PDs	SPoT	An	SR	MDC	MDD	FuP	PT	Score
Maughan and Miller (1983)[c,d]	N	Y	Y	Y	Y	Y	Y	N	Y	Y	8/10
Linde (1986)[c]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	9/10
Collins et al. (1989)[c]	Y	Y	Y	N	Y	Y	Y	N	na	Y	7/9
van Mechelen et al. (1993)[b]	Y	Y	N	Y	N	Y	Y	N	N	Y	6/10
Jakobsen et al. (1994)[c,d]	Y	Y	Y	N	Y	Y	Y	N	Y	Y	8/10
Wen et al. (1998)[d]	Y	Y	Y	N	Y	Y	Y	N	Y	Y	8/10
Williams et al. (2001)	N	Y	Y	N	Y	Y	Y	N	na	Y	6/9
Chorley et al. (2002)[d]	Y	Y	N	N	Y	Y	Y	Y	N	Y	7/10
Taunton et al. (2003)[a,b]	Y	Y	N	N	Y	Y	Y	N	N	Y	6/10
Taunton et al. (2002)[a,b,c]	Y	Y	N	N	Y	N	Y	Y	N	Y	6/10
Lun et al. (2004)[d]	Y	Y	N	N	N	Y	Y	N	na	Y	5/9
McKean et al. (2006)[d]	Y	Y	N	N	Y	Y	Y	Y	na	Y	7/9
Van Middelkoop et al. (2008)[b,d]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	9/10
Knobloch et al. (2008)[c]	Y	Y	Y	N	Y	Y	Y	N	na	Y	7/9
Van Ginckel et al. (2009)	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Ryan et al. (2011)[a,d]	Y	Y	Y	N	N	Y	Y	N	N	Y	6/10
Lopes et al. (2011)[a,b,d]	Y	Y	Y	Y	Y	Y	Y	N	na	Y	8/9
Bredeweg et al. (2012)	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Chang et al. (2012)[d]	N	Y	Y	N	Y	Y	Y	N	na	Y	6/9
Hespanhol Junior et al. (2012)[c,d]	Y	Y	Y	N	Y	Y	Y	N	Y	Y	8/10
Vadeboncoeur et al. (2012)[a,d]	Y	Y	Y	N	N	Y	Y	N	N	Y	6/10
Hendricks and Phillips (2013)[d]	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Rasmussen et al. (2013)[d]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	9/10
Hespanhol Junior et al. (2013)[d]	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Ogwumike and Adeniyi (2013)[d]	N	Y	Y	Y	Y	N	Y	Y	na	Y	7/9
Nielsen et al. (2014)[a,b,c,d]	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	9/10
Theisen et al. (2014)[d]	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Malisoux et al. (2015)[d]	Y	Y	Y	N	N	Y	Y	N	N	Y	6/10
Altman and Davis (2016)[c]	N	Y	Y	Y	Y	Y	Y	N	Y	Y	8/10
Kerr et al. (2016)[a,b]	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Teixeira et al. (2016)[d]	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	9/10
van der Worp et al. (2016)[a,d]	Y	Y	Y	Y	Y	Y	Y	N	N	Y	8/10
Hespanhol Junior et al. (2016)[c,d]	Y	Y	Y	N	Y	Y	Y	N	N	Y	7/10
Malisoux et al. (2016a)[d]	Y	Y	Y	N	Y	Y	Y	N	Y	Y	8/10
Smits et al. (2016)	Y	Y	Y	Y	N	Y	Y	N	N	Y	7/10
Hespanhol Junior et al. (2017a)[c,d]	Y	Y	Y	N	Y	Y	Y	N	Y	Y	8/10

ID = Injury Definition; PDt = Proportion Data; PDs = Population Description; SPoT = Sampling Population or Target; An = Analysis (≥80% of sample); SR = Self-Reported; MDC = Mode Data Collection; MDD = Medical Doctor Diagnosis; FuP = Follow-up Period; PT = Proportion of Total; Y= yes, N= no, na = not applicable. a, b, c, d = as per Table 1.

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Key points

- The highest proportion of running injury occurs from the knee downwards.
- The top 3 anatomical locations for running injuries are common to both genders but women seem to suffer more knee injuries relative to men.
- Injuries reported using medical diagnosis appear to mirror the anatomical locations most commonly injured.
- Greater standardisation of injury audit tools are required in order to be able to perform meta-analysis on the prevalence and incidence of injury in runners.

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